CEVE / ESCI / ENST 307 and 507
ENERGY AND THE ENVIRONMENT
SPRING 2019

Meeting Times and Location:
T/Th 9:25 – 10:40 a.m., Rayzor 119

Instructor:
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Office Hours:
Wednesdays 1:30 – 3:30 p.m. Visits at other times are also welcomed, via email request.

Course Description:
Securing sufficient, reliable, and affordable supplies of energy in an environmentally sustainable manner is among the greatest challenges facing society in the 21st century. Appreciating and addressing this complex challenge requires consideration of the various physical, technological, and societal forces that shape energy use and its impact on the environment.

This course will explore the physical principles of energy and how various sectors and fuels impact Earth's environment and climate. We will also examine policies and technologies that could foster more sustainable use of energy resources. The course will include a group project in which each team of students will design a plan to address a business challenge in a profitable and environmentally beneficial manner.

Course Objectives and Expected Learning Outcomes:
This course aims not only to impart heightened knowledge of energy and its impacts on the environment, but also to build skills in research, analysis, and critical thinking that will catalyze a lifetime of engagement with this complex topic. Among the learning objectives for this course, students completing this course will be able to:

1) Characterize the performance of engines, heat pumps, and power plants
2) Identify key environmental impacts of various energy sources
3) Compute the energy return on investment, overall efficiency, and resource intensity for an energy source
4) Obtain objective, credible data and projections for energy availability, consumption, and impacts, and critically evaluate conflicting estimates
5) Conduct in-depth research on an energy topic, and present findings in a poster
6) Design and present a business plan, compute its financial and environmental impacts, and identify its practical and regulatory challenges

The course addresses the following ABET student outcomes for the BSCE degree:

(ABET Outcome 1) an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics;

(ABET Outcome 2) an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors;

(ABET Outcome 3) an ability to communicate effectively with a range of audiences;

(ABET Outcome 4) an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts;

(ABET Outcome 5) an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives;

(ABET Outcome 7) an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

Prerequisites:

This course will apply quantitative approaches, scientific principles, and policy analysis to examine energy and the environment. Physics and calculus background at least to the level of PHYS 101 and MATH 101 (or AP equivalents) are required. Please contact the instructor if you have questions regarding your preparation.

Textbook and Readings:

Readings will be made available on the Canvas website for the course.

Honor System Policy:

All students are expected to adhere to the Rice Honor Code. Exams will be given under the honor system and must be entirely a student's own work, using only resources that are explicitly authorized for that exam. Homework assignments may be discussed with other students but must be written individually in your own words. To avoid any possibility of plagiarism, all work must be written **entirely in the student's own words**, citing all references used and explicitly denoting any quotes in quotation marks.

Disability Statement:

If you have a documented disability that will impact your work in this class, please contact me to discuss your needs. Additionally, you will need to contact the Disability Support Services Office in the Allen Center.

Grading:

Written assignments (~5)	25%
Midterm exam	25%
Poster presentation and report	20%
Group presentation	15%
Group report	15%
Attendance, participation, in-class activities	up to +/- 5 points

Assignments:
While there will be some traditional textbook-style problems, assignments will also involve analyzing energy data resources and engaging with scientific literature and assigned readings. This higher-level thinking and an ability to obtain and analyze real-world data are crucial given the rapidly evolving nature of energy and the environment. To lighten the workload, there will only be 5 assignments and they will be shorter than in previous years.

All assignments are due by the end of class on the due date unless otherwise stated. Late assignments will incur a penalty of 25 points and will not be accepted after solutions are distributed. Extensions will be granted only by email request describing specific extenuating circumstances.

Exam:
The midterm exam will be given in a take-home format and will cover the core conceptual material from the course. Tentative Date: Assigned March 20; Due March 26

Poster Presentation and Research Report:
Students will present a poster individually in one of the poster sessions, providing either original research or a critical review on a topic of their choice. They will later write up their findings in a brief research report (~4 pages plus references).

Group Projects:
The group projects are a critical component of the course. Each team of three students will develop a business plan to address a challenge statement provided by a mentor from a local business, agency, or university, and evaluate the associated financial and environmental impacts. Teams will present their recommendations to their mentors and peers at the end of the semester. Details will be provided later.

Attendance, Participation, and In-class Activities:
Attendance and participation are crucial to the success of this course. Expectations are:

- Attendance of all classes, except in extenuating circumstances with email note
- Participation in small group discussions and other in-class activities
- Full involvement with group project team, including in-class discussions, meetings with mentor, and a practice session before oral presentation

Points may be added to the final grade for especially active participation in class and/or office hours, or subtracted for not meeting the basic expectations above.

CEVE 507:
Graduate students will complete an additional problem on some assignments, and will have more challenging expectations for other course work. Details TBD based on graduate enrollment in the course.

TENTATIVE SCHEDULE (*subject to change*)

DATE	THEME	TOPIC
1/8	**Introduction**	The Energy Challenge
1/10	**Physical Principles**	Discussion of energy outlooks Energy, work, heat, and power; First Law of Thermodynamics; Efficiency of energy conversions
1/15		Heat Transfer and its implications for efficiency of buildings
1/17		Second Law of Thermodynamics; Intro to heat engines
1/22		Types of heat engines; Refrigerators and heat pumps **(*Business challenges introduced*)**
1/24	**Evaluation Metrics**	Financial metrics (levelized cost, internal rate of return, net present value); Prospect theory
1/29		Energy use and Environmental metrics
1/31	**Environmental Challenges**	Water, Land and Food
2/5		Air
		SPRING RECESS
2/12		Climate
2/14		Climate (continued)
2/19		Emission control technologies
2/21		**Poster Session 1***
2/26	**Energy Sectors and Policies**	Electricity and the Electric Sector
2/28		Transportation Sector
3/5		Policy Approaches
3/7		**Poster Session 2***
3/11 – 3/15		SPRING BREAK
3/19	**Fuels and Resources**	Oil and Natural Gas
3/21		Coal and Nuclear
3/26		Biofuels (**Take-home Midterm Due**)
3/28		Solar and Wind
4/2		**Poster Session 3***
4/4		Efficiency; Energy Storage; Demand Response
4/9		Hydropower, Oceans, Geothermal, Future options
4/11	**Presentations****	**Group Presentations**
4/16		**Group Presentations**
4/18		**Group Presentations**

* These class periods will be devoted to posters presented by individual students
** These class periods will be devoted to presentations by teams of 3 students